Impacts of Dam Operations in the Mekong River Basin on Discharge and Sediment Transport to the Mekong Delta

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1. Introduction
The Mekong River mainstem hosts 13 operational dams. In 2009, the Xiaowan Dam began operation in China. Kummu et al. noted that Xiaowan Dam operations have reduced sediment transport downstream[1)]. Subsequently, the Don Sahong Dam, Xaiyaburi Dam, and Lower Sesan 2 Dam commenced operations in 2019. Reduced sediment transport causes shoreline retreat[2)]. Therefore, understanding changes in sediment transport to the Mekong Delta is critically important. However, quantitative assessment has not been conducted on the impact of the existing dam, including the dams that began operation in 2019, on sediment transport in the Mekong Delta.
Considering the above, the objective of this study is to clarify the long-term changes in sediment transport in the Mekong Delta and to reveal the impact of dam operation on sediment transport.
2. Target Area and Data Used
This study selected the Kratie site as the representative location for defining sediment transport into the Mekong Delta. This site is located at the delta entrance and is considered unaffected by tidal influences[3)]. The data used are discharge and total suspended solid (TSS) data for the Kratie site provided by the Mekong River Commission (MRC).
3. Research Method
To clarify the long-term changes in sediment transport, this study calculated sediment transport volume using the following Equation (1).
$SSL = Q \times TSS \times 1000$
Here, SSL is suspended sediment load (kg/s), Q is daily discharge (m^3/s), and TSS is total suspended solid (mg/l).
A modified Mann-Kendall test[4)] (modified MK test) was performed on the monthly observed data for daily discharge, TSS, and SSL at the Kratie site. Based on the start-up years of major dams, the periods 1996-2008, 1996-2018, and 1996-2023 were defined as the first, second, and third periods, respectively, and these three periods were compared.
4. Results
The modified MK test for daily discharge revealed a significant increasing trend in March and May of the third period. Daily discharge increased during the dry season months of March and May, suggesting that dam reservoir development in the Mekong River basin contributes to stable flow supply. The results of the modified MK test for TSS showed a significant decreasing trend in January, September, and November of the third period. The decrease in these TSS is thought to be partly caused by sediment trapping associated with dam operations in the upper river basin. The results of the modified MK test for SSL showed a significant decreasing trend in August, September, and November of the third period. These results clearly indicate that sediment transport has been gradually decreasing due to dam operations within the watershed.
5. Summary
The modified MK test revealed that sediment transport significantly decreased in August, September, and November following the dam operations in 2009 and 2019.As new dam developments are planned in the Mekong River basin, the potential for increased sediment transport issues is extremely high. It is crucial to

consider design and operational strategies that adequately account not only for changes in discharge but also for impacts on sediment transport.

References

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Table 1. Results of the Modified MK Test for Daily Discharge, TSS, and SSL at Kratie Station

Variable	Period	Year	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Discharge (m^3/s)	First Period	-	+5%	+	-	+	-	+	+	+	+	-	-	-	+
	Second Period	-	+1%	+	+	+5%	+5%	+1%	+	+	-	-	-	-	+
	Third Period	-	+	+	+	+5%	+	+5%	+	-	-5%	-	-	-	-
TSS (mg/L)	First Period	-	-	+	-	-	+	-	+	-	-	-5%	+	-	-
	Second Period	+	-	-	+	-	-	-	+	+	-	-	-	-	-
	Third Period	-	-	-5%	+	-	-	-	-	-	-	-1%	-	-5%	-
SSL (kg/s)	First Period	-	-	+	-	-	+	+	+	-	+	-	+	-	-
	Second Period	-	+	-	+	+	+	+	+	+	-	-5%	-	-5%	-
	Third Period	-5%	-	-	+	+	+	+	+	-	-1%	-1%	-	-5%	-

Note: In the table, "–" indicates a negative trend, "+" indicates a positive trend, and the numbers represent the significance level. Significant increasing trends are shown in red, and significant decreasing trends are shown in blue. Non-significant increasing trends are shown in orange, and non-significant decreasing trends are shown in light blue.

